DOCUMENT RESUME

ED 182 129 SE 029 762

AUTHOR Williams, Robert C.
TITLE Stoichiometry, Unit 1: The Mole Concept. A Computer-Enriched Module for Introductory Chemistry. Student's Guide and Teacher's Guide.
INSTITUTION Illinois Inst. of Tech., Chicago.
SPONS AGENCY EXXON Education Foundation, New York, N.Y.; National Science Foundation, Washington, D.C.
PUB DATE 76
NOTE 47p.; For related documents, see SE 029 752-763; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Chemistry; College Science; *Computer Assisted Instruction; Computer Programs; *Higher Education; *Independent Study; Instructional Materials; *Learning Modules; Problem Solving; *Science Education; Science Instruction; Simulation; Undergraduate Study
IDENTIFIERS *Computer Enriched Module Project

ABSTRACT

Presented are the teacher's guide and student manual for one of a series of self-instructional, computer-based learning modules for an introductory, undergraduate chemistry course. The student manual for this unit on the concept of the mole includes objectives, prerequisites, discussion, problem exercises, and 20 problem sets. Included in the teacher's guide are implementation instructions, references, answers to problem sets, sample run of the program showing a quiz being printed and students' answers being graded, a listing of the computer program in BASIC, and 10 unit tests. (BT)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED182129

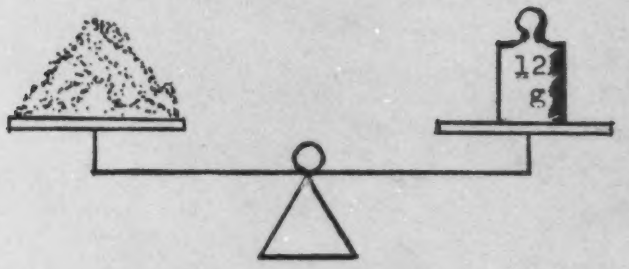
STOICHIOMETRY

UNIT 1. THE MOLE CONCEPT

ROBERT C. WILLIAMS
UNIVERSITY OF NEBRASKA

A COMPUTER-ENRICHED MODULE FOR INTRODUCTORY CHEMISTRY

6.02×10^{23}
atoms of carbon



U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Mary L. Charles
NSF
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Supported by grants from the
National Science Foundation
Exxon Foundation

Copyright by CM Publications 1976
Illinois Institute of Technology
Chicago, Illinois 60616

SE 029 762

OBJECTIVES

When you finish this unit you will know

1. what a mole is, and how to convert between moles and
   a. the number of atoms or molecules
   b. the weight of a chemical species
   c. the gaseous volume under ideal conditions.
2. how to solve percent composition problems.
3. how to calculate the empirical and molecular formulas from a given percent composition analysis.

PREREQUISITES

You should have mastered the use of conversion factors, before attempting this module. Read the Appendix on Conversion Factors. If you can answer he questions in that manual, you are ready to start this module.

INTRODUCTION

The mole concept is the foundation on which all quantitative chemistry is built. An understanding of this concept is essential to solving problems in chemistry. In this module, we will explain what a mole is, and show some typical uses of this concept.

DISCUSSION

You have learned that units are attached to numbers to give them physical significance. You also learned to convert between different sets of units. One reason for converting between different sets of units is that some units are more useful than others for a given situation. For example, we would normally report the distance between New York and Chicago in miles or kilometers rather than in inches or millimeters. Conversely, we might measure a collar size in inches or centimeters, but we probably wouldn't use miles or kilometers. A baker often measures bakery goods in dozens, because he makes too many items to conveniently classify them in smaller units. In each case, the units used are chosen for their convenience.

Because atoms are such small entities, it is impossible to use or work with individual atoms in most chemical reactions. What is needed is a unit representing a number of atoms which can reasonably and conveniently be handled by the average chemist. This unit is the "mole", and is to a chemist what the dozen is to a baker. A mole of anything is defined as 6.023×10^{23} of these things. While this unit could be used to describe anything (just as we could express a collar size in kilometers), its size makes it most convenient to use for atoms and molecules. The

number 6.023×10^{23} is called "Avogadro's number".

1 dozen = 12
1 gross = 144
1 mole = 6.023×10^{23}

Example 1. How many moles are there in 1.506×10^{24} atoms of helium? This problem is a simple conversion problem, from atoms to moles. The conversion factors are 1 mole He = 6.023×10^{23} He atoms. We use this conversion factor as follows:

$$1.506 \times 10^{24} \text{ atoms He} \times \frac{1 \text{ mole He}}{6.023 \times 10^{23} \text{ atoms He}} = 2.5 \text{ moles He}$$

Example 2. How many molecules are there in 0.75 moles of CH_4? How many atoms?
Answer to the first part:

$$0.75 \text{ moles } CH_4 \times \frac{6.023 \times 10^{23} \text{ molecules } CH_4}{1 \text{ mole } CH_4} = 4.5 \times 10^{23} \text{ molecules } CH_4$$

Answer to the second part:
Since there are four hydrogen atoms and one carbon atom for each molecule, there are five atoms per molecule of CH_4.

$$0.75 \text{ moles } CH_4 \times \frac{6.023 \times 10^{23} \text{ molecules } CH_4}{1 \text{ mole } CH_4} \times \frac{5 \text{ atoms}}{1 \text{ molecule}} = \frac{2.25 \times 10^{24}}{\text{atoms}}$$

The weight in grams of an Avogadro's number of atoms or molecules is numerically equal to the atomic or molecular weight in atomic mass units (amu). Thus, one mole of sodium atoms (atomic weight = 23.0 amu) weighs exactly 23.0 grams, and one mole of hydrogen chloride gas (molecular weight = 36.46 amu) weighs 36.46 g. When referring to one mole of atoms, the term "gram-atom" is often used instead of "mole".

Example 3. How many moles are there in 30.0 g of carbon?
The required conversion factor is

$$1 \text{ mole C} = 12.0 \text{ g C} .$$

Then the problem is solved

$$30.0 \text{ g C} \times \frac{1 \text{ mole C}}{12.0 \text{ g C}} = 2.5 \text{ mole C}$$

Example 4. How much do 3 moles of water weigh?

Answer: $3 \text{ moles } H_2O \times \frac{18 \text{ g } H_2O}{1 \text{ mole } H_2O} = 54.0 \text{ g } H_2O$

Example 5. How many grams is 9.820 gram atoms of Si?

$$9.820 \text{ gram atoms of Si} \times \frac{28.086 \text{ g Si}}{1 \text{ gram atom Si}} = 276 \text{ g}$$

Example 6. If one atom of element X weighs 6.658×10^{-23} g, what is the atomic weight of X?

$$\frac{6.658 \times 10^{-23} \text{ g}}{1 \text{ atom}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mole}} = 40.1 \text{ g/mole}$$

Example 7. What is the molecular weight of SiF_4?

Atomic weights: Si 28.086
F 19.

Molecular weight of SiF_4 = 28.086 + 4 (19)
= 104.086

Example 8. What is the mass in grams of 3.46×10^{24} atoms of S?

$$3.46 \times 10^{24} \text{ S atoms} \times \frac{1 \text{ mole S}}{6.02 \times 10^{23} \text{ S atoms}} \times \frac{32 \text{ g}}{1 \text{ mole S}} = 184 \text{ g}$$

Example 9. How many grams of F are in 0.650 moles of SeF_4?

$$0.650 \text{ moles of } SeF_4 \times \frac{4 \text{ moles of F}}{1 \text{ mole } SeF_4} \times \frac{19 \text{ g of F}}{1 \text{ mole F}} = 49.4 \text{ g}$$

EXERCISES

1. WHAT IS THE MASS IN GRAMS OF 3.96709E+24 ATOMS OF O ?
2. HOW MANY GRAMS IS 9.330 GRAM ATOMS OF O?
3. IF ONE ATOM OF ELEMENT X WEIGHS 1.796E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?
4. HOW MANY ATOMS ARE THERE IN 11.797 GRAMS OF Cu ?
5. HOW MANY GRAM ATOMS OF C ARE THERE IN 77.798 GRAMS OF C ?
6. WHAT IS THE MOLECULAR WEIGHT OF NO_2 ?
7. ONE MOLE OF CO_2 IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF PCl_3 MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF CO_2 ?
8. WHAT IS THE MASS (IN GRAMS) OF 6.620 MOLES OF SiC?
9. HOW MANY MOLECULES OF HF ADD UP TO A MASS OF 19.900 GRAMS?
10. HOW MANY MOLES OF Br_2 MOLECULES ARE THERE IN 14.950 GRAMS OF Br_2 ?
11. HOW MANY ATOMS OF Ca ARE THERE IN 5.640 GRAMS OF CaF_2?
12. HOW MANY ATOMS OF C ARE THERE IN 2.33570E+24 MOLECULES OF CO?
13. HOW MANY GRAMS OF N ARE IN 5.611E+24 MOLECULES OF N_2?
14. HOW MANY GRAMS OF Ca ARE IN 1.765 MOLES OF CaF_2?
15. HOW MANY MOLES OF Cr ATOMS ARE THERE IN 10.799 GRAMS OF Cr_2O_3?

ANSWERS

1. 1.05E+02	6. 4.60E+01	11. 4.35E+22
2. 1.49E+02	7. 3.20E-01	12. 2.34E+24
3. 1.08E+01	8. 2.65E+02	13. 2.61E+02
4. 1.12E+23	9. 5.99E+23	14. 7.07E+01
5. 6.48E+00	10. 9.35E-02	15. 1.42E-01

VOLUME OF A GAS AT STP*

One mole of a gas will occupy a volume of 22.4 liters at 0°C and one atmosphere of pressure. The combination of 0°C and 1 atmosphere is called standard temperature and pressure, abbreviated STP. Later, you will learn how to convert between volume and moles under other conditions, but for now we will limit our discussion to STP. One mole of a gas occupies a volume of 22.4 liters at STP.

Example 10. How many moles of chlorine gas are there in 33.6 l at STP?

The required conversion factor is

$$1 \text{ mole } Cl_2 = 22.4 \text{ l } Cl_2 \text{ (STP)}.$$

Then unit conversion gives the answer

$$33.6 \text{ l } Cl_2 \text{ (STP)} \times \frac{1 \text{ mole } Cl_2}{22.4 \text{ l } Cl_2 \text{ (STP)}} = 1.5 \text{ moles } Cl_2$$

Example 11. How much volume will 3.5 moles He occupy at STP?

Answer: $3.5 \text{ moles He} \times \frac{22.4 \text{ l He (STP)}}{1 \text{ mole}} = 78.4 \text{ l (STP)}$

Problems on Relationship between Moles and Volume at STP

1. HOW MANY MOLES ClO_2 ARE THERE IN 29.498 LITERS OF ClO_2 AT STANDARD CONDITIONS (0 DEGREES AND 1 ATM PRESSURE)?
2. HOW MANY GRAMS OF NO_2 OCCUPY 1.260 LITERS AT STANDARD CONDITIONS?
3. HOW MANY MOLECULES OF NH_3 ARE IN 75.597 LITERS OF NH_3 AT STANDARD CONDITIONS?
4. HOW MANY GRAM ATOMS OF H ARE IN 3.250 LITERS OF PH_3 AT STANDARD CONDITIONS?
5. WHAT IS THE WEIGHT (IN GRAMS) OF Si ATOMS IN 87.798 LITERS OF SiH_4 AT STANDARD CONDITIONS?
6. HOW MANY O ATOMS ARE THERE IN 5.630 LITERS OF SO_3 AT STANDARD CONDITIONS?

* This section may be skipped.

ANSWERS

1. 1.32E+00
2. 2.59E+00
3. 2.03E+24
4. 4.35E-01
5. 1.10E+02
6. 4.54E+23

PERCENT COMPOSITION

Occasionally, it is necessary to calculate the percent composition of a particular component in a compound or mixture. For example, Ivory soap is said to be 99.44% pure. This means that of each 100 grams of powder in the soapbox, 99.44 g are soap, and 0.56 g are some other material. A particular course may contain 25% freshmen. Then, on the average, for every 100 people in the class, 25 would be freshmen. The general formula for percent composition is

$$\% \text{ of A in a mixture} = \frac{\text{amount of A}}{\text{amount of total mixture}} = 100\%$$

Note that the formula doesn't specify how the "amount" is measured. In this module, we'll also measure by weight and calculate <u>weight percents</u>. Later on you will need to calculate volume percent and mole percent.

<u>Example 12</u>. A given brand of cat food is analyzed and found to contain 2.5 g protein in a 20.0 gram sample. What is the percent of protein in the cat food?

Answer: $\% \text{ protein} = \frac{\text{wt protein}}{\text{wt sample}} \cdot 100\%$

$$= \frac{2.5}{20} \times 100\% = 12.5\%$$

You can also reverse the process; you can calculate the actual amount of a given component, if you know the percent composition and the total mixture weight.

<u>Example 13</u>. The same cat food contains "not more than 3% ash". What is the maximum amount of ash in a 40 gram sample?

Answer: $40 \text{ g sample} \times \frac{3\% \text{ ash}}{100\% \text{ sample}} = 1.2 \text{ g ash}$

Example 14. Calculate the percent by weight of each element in $H_2O_7S_2$.

One mole of $H_2O_7S_2$ weighs

$$2(1) + 7(16) + 2(32) = 178 \text{ g}.$$

In one mole of $H_2O_7S_2$ are

2(1) grams of H or 2 g

7(16) grams of O or 112 g

2(32) grams of S or 64 g

Percent by weight:

$$\text{H: } \frac{2}{178} \times 100 = 1.12\% \text{ H}$$

$$\text{O: } \frac{112}{178} \times 100 = 62.92\% \text{ O}$$

$$\text{S: } \frac{64}{178} \times 100 = 35.96\% \text{ S}$$

EMPIRICAL AND MOLECULAR FORMULAS FROM ANALYSIS

In order to find the relative number of atoms of the different elements in a compound, we must determine by chemical analysis, the relative weights of the elements making up the compound. Let us see how this is done.

Example 15. Glucose, a type of sugar, is found to consist of 40.00% carbon, 6.66% hydrogen, and 53.33% oxygen. What is the simplest chemical formula consistent with this analysis? The easiest way to solve this problem is to assume we have a given amount of sugar, say 100 grams. (We'll show later that any other number would also work, but 100 is a nice, neat number.) Then in this 100 g, we have

$$100 \text{ g sample} \times \frac{40.00\% \text{ C}}{100\% \text{ sample}} = 40.00 \text{ g C}$$

$$100 \text{ g sample} \times \frac{6.66\% \text{ H}}{100\% \text{ sample}} = 6.66 \text{ g H}$$

$$100 \text{ g sample} \times \frac{53.33\% \text{ O}}{100\% \text{ sample}} = 53.33 \text{ g O}$$

We can also find the number of moles of C, H, and O in 100 g of sample.

$$40.00 \text{ g C} \times \frac{1 \text{ mole C}}{12.0 \text{ g C}} = 3.33 \text{ mole C}$$

$$6.66 \text{ g H} \times \frac{1 \text{ mole H}}{1.0 \text{ g H}} = 6.66 \text{ mole H}$$

$$53.33 \text{ g O} \times \frac{1 \text{ mole O}}{16.0 \text{ g O}} = 3.33 \text{ mole O}$$

Thus we find that in glucose the ratios of the number of atoms of C, H and O is C:H:O = 3.33:6.66:3.33, or in small whole numbers, 1:2:1. The 1:2:1 ratio is easy to see if we divide each number of moles by the smallest number:

$$\frac{3.33 \text{ mole C}}{3.33 \text{ mole}} = 1 \text{ C}$$

$$\frac{6.66 \text{ mole H}}{3.33 \text{ mole}} = 2 \text{ H}$$

$$\frac{3.33 \text{ mole O}}{3.33 \text{ mole}} = 1 \text{ O}$$

Thus the ratio of C:H:O is 1:2:1. (It's at this point that the number of grams we initially chose "cancels" out. If we had chosen 200 g, we'd have had 6.66 mole C, 13.32 mole H, and 6.66 mole O, but the ratio would still be 1:2:1.) The simplest chemical formula is $C_1H_2O_1$.

Sometimes the ratios found are not of small, whole numbers. In that case, we multiply each number in the ratio by 2. If we still don't have small, whole numbers, multiply the original by 3. If that doesn't work, successively try 4, 5, up to 9. (If it doesn't work by that time, go back and check your arithmetic.)

Example 16. Propane is a compound which contains only carbon and hydrogen. A chemical analysis of propane reveals that it is 18.18% hydrogen. Find the simplest chemical formula for propane.

If 18.18% of propane is hydrogen, then the rest of propane or 81.82% must be carbon. Then in 100 g of sample, there are 81.82 g carbon and 18.18 g hydrogen. Then there are

$$81.82 \text{ g C} \times \frac{1 \text{ mole C}}{12.0 \text{ g C}} = 6.8 \text{ moles C, and}$$

$$18.18 \text{ g H} \times \frac{1 \text{ mole H}}{1.0 \text{ g H}} = 18.18 \text{ moles H.}$$

The C:H ratio is 6.8:18.18. What is it in terms of small whole numbers? Let's see. Dividing both sides by 6.8 moles, the ratio of C to H is

$$\frac{6.8 \text{ moles C}}{6.8 \text{ moles}} = 1 \quad \text{C}$$

$$\frac{18.18 \text{ moles H}}{6.8 \text{ moles}} = 2.67 \text{ H} \qquad \text{C:H} = 1:2.67$$

Multiplying by 2 yields C:H = 2:5.34, but 5.34 is not close enough to any whole number. Multiplying by 3 gives C:H = 3:8.01. If we allow for errors in the experimental determination of percent composition, this is reasonably close to 3:8, and the simplest formula for propane is probably C_3H_8.

The simplest possible formula is also called the empirical formula. The molecular formula indicates the number of atoms in a molecule of a molecular substance. The molecular formula may be identical with the simplest formula, or the molecular formula may be an integral multiple of the simplest formula. The molecular formula can be determined if the molecular weight is known.

Example 17. The molecular weight of glucose is 180 g/mole. What is the formula of glucose?

The weight of the empirical formula for glucose $C_1H_2O_1$ (see Example 15) is 30 g. Since the molecular weight is 180, there must be 180/30 or 6 $C_1H_2O_1$ groups in glucose. Therefore, the molecular formula is $C_6H_{12}O_6$.

Example 18. If the molecular weight of propane is 44 g/mole, what is the molecular formula for propane?

The weight of the empirical formula, C_3H_8, is 44 g/mole. Thus, the empirical formula is also the molecular formula in this case.

The steps used to solve these problems can be summarized as follows:

Step 1

Calculate the number of grams of each component, assuming some convenient amount of sample (usually 100 g).

Step 2

Calculate the number of moles of each component, by dividing the weight of each component by the atomic weight of that component.

Step 3

Divide each quotient from Step 2 by the smallest quotient from Step 2 in order to find the simplest ratios.

Step 4

If the resulting numbers are not integers, successively multiply every number in the ratio by small, whole integers, until all the numbers in the ratio are whole numbers. These numbers are the ones associated with each component in the empirical formula.

Step 5

If the molecular weight is given, divide it by the empirical weight. Multiply the empirical formula by this factor in order to get the molecular formula.

The following example shows specifically where each step is applied. Examine it carefully. Now see if you can identify the steps in Examples 15 through 18. When you thoroughly understand these examples, you may complete this module using the program MOLE which will provide additional practice problems of this type.

Example 19. Phosphorus pentoxide contains only phosphorus and oxygen. Chemical analysis reveals that this compound contains 56.33% oxygen, and has a molecular weight of 284 g/mole. Find the molecular formula.

Step 1

Assume 100 g compound.

$$\text{g oxygen} = 100 \text{ g compound} \times \frac{56.33\% \text{ O}}{100\% \text{ compound}} = 56.33 \text{ g O}$$

$$\text{g phosphorus} = 100 - 56.33 = 43.67 \text{ g P}$$

Step 2

$$56.33 \text{ g O} \times \frac{1 \text{ mole O}}{16.0 \text{ g O}} = 3.52 \text{ moles O}$$

$$43.67 \text{ g P} \times \frac{1 \text{ mole P}}{31.0 \text{ g P}} = 1.41 \text{ moles P}$$

Step 3

$$\frac{3.52 \text{ moles O}}{1.41 \text{ moles}} = 2.5 \text{ O}$$

$$\frac{1.41 \text{ moles P}}{1.41 \text{ moles}} = 1 \text{ P}$$

Step 4

P:O = 1:2.5

Multiply by 2: P:O = 2:5

Empirical formula = P_2O_5

Step 5

Empirical weight = 2(31) + 5(16) = 142

Formula weight = 284

$\frac{284}{142} = 2$

Molecular formula = $2 \times P_2O_5 = P_4O_{10}$

Now use the program MOLE to generate a unique set of problems that you may use to test your understanding of these ideas.

Problem Set 1

1. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_6H_6 ?

2. HOW MANY ATOMS ARE THERE IN 73.800 GRAMS OF Ti ?

3. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 80.00
   H 20.00
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

4. THE EMPIRICAL FORMULA OF A COMPOUND IS C_2H_6O.
   ITS MOLECULAR WEIGHT IS 46.00. WHAT IS ITS MOLECULAR FORMULA?

5. HOW MANY MOLES OF Sn ATOMS ARE THERE IN 17.797 GRAMS OF $SnCl_2$?

6. HOW MANY MOLES OF N_2O_4 MOLECULES ARE THERE IN 37.849 GRAMS OF N_2O_4 ?

Problem Set 2

1. THE EMPIRICAL FORMULA OF A COMPOUND IS CH_4N.
   ITS MOLECULAR WEIGHT IS 60.00. WHAT IS ITS MOLECULAR FORMULA?

2. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_6H_{14}.

3. WHAT IS THE MASS IN GRAMS OF 4.23789E+24 ATOMS OF C ?

4. HOW MANY MOLECULES OF O_2 ADD UP TO A MASS OF 26.299 GRAMS?

5. HOW MANY GRAMS OF Rb ARE IN 1.295 MOLES OF RbP?

6. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 25.53
   H 6.38
   O 68.09
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

Problem Set 3

1. HOW MANY MOLES OF CC_2 MOLECULES ARE THERE IN 47.450 GRAMS OF CO_2 ?

2. HOW MANY ATOMS OF Se ARE THERE IN 7.82570E+23 MOLECULES OF H_2Se?

3. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_6H_6 ?

4. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 80.00
   H 20.00
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

5. THE EMPIRICAL FORMULA OF A COMPOUND IS CH.
   ITS MOLECULAR WEIGHT IS 78.00. WHAT IS ITS MOLECULAR FORMULA?

6. IF ONE ATOM OF ELEMENT X WEIGHS 7.957E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

Problem Set 4

1. HOW MANY GRAMS OF Br ARE IN 9.391E+23 MOLECULES OF HBr?

2. HOW MANY ATOMS ARE THERE IN 93.899 GRAMS OF Si ?

3. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 42.86
   H 2.38
   O 38.10
   N 16.67
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

4. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_6H_{14}.

5. THE EMPIRICAL FORMULA OF A COMPOUND IS $CH_3N_2O_2$.
   ITS MOLECULAR WEIGHT IS 150.00. WHAT IS ITS MOLECULAR FORMULA?

6. WHAT IS THE MOLECULAR WEIGHT OF N_2O_4 ?

Problem Set 5

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 16.00
   H 4.00
   O 42.67
   N 37.33
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. HOW MANY MOLES OF PH_3 MOLECULES ARE THERE IN 46.999 GRAMS OF PH_3 ?

3. WHAT IS THE MASS IN GRAMS OF 2.94361E+24 ATOMS OF Ge ?

4. THE EMPIRICAL FORMULA OF A COMPOUND IS C_3H_7.
   ITS MOLECULAR WEIGHT IS 86.00. WHAT IS ITS MOLECULAR FORMULA?

5. HOW MANY MOLES OF H ATOMS ARE THERE IN 25.799 GRAMS OF C_6H_6?

6. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN CaO ?

Problem Set 6

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 52.17
   H 13.04
   O 34.78
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. THE EMPIRICAL FORMULA OF A COMPOUND IS $C_7H_6O_3$.
   ITS MOLECULAR WEIGHT IS 138.00. WHAT IS ITS MOLECULAR FORMULA?

3. HOW MANY ATOMS OF Zn ARE THERE IN 5.780 GRAMS OF $ZnCl_2$?

4. WHAT IS THE MASS IN GRAMS OF 3.82269E+24 ATOMS OF Br ?

5. HOW MANY MOLES OF CH_3F MOLECULES ARE THERE IN 25.649 GRAMS OF CH_3F ?

6. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN $CuSO_4$?

Problem Set 7

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 10.81
   H 2.70
   O 28.83
   S 57.66
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. HOW MANY GRAMS OF O ARE IN 6.742E+23 MOLECULES OF ClO_2?

3. HOW MANY GRAM ATOMS OF Ti ARE THERE IN 45.300 GRAMS OF Ti ?

4. HOW MANY MOLECULES OF CO ADD UP TO A MASS OF 18.049 GRAMS?

5. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_5O_2N$.

6. THE EMPIRICAL FORMULA OF A COMPOUND IS $C_3H_7O_2N$.
   ITS MOLECULAR WEIGHT IS 89.00. WHAT IS ITS MOLECULAR FORMULA?

Problem Set 8

1. ONE MOLE OF HBr IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE.
   HOW MANY MOLES OF BF_3 MUST BE PLACED ON THE OTHER PAN
   TO EXACTLY BALANCE THE MOLE OF HBr ?

2. THE EMPIRICAL FORMULA OF A COMPOUND IS NO_2.
   ITS MOLECULAR WEIGHT IS 92.00. WHAT IS ITS MOLECULAR FORMULA?

3. HOW MANY GRAMS OF O ARE IN 4.065 MOLES OF CO_2?

4. HOW MANY ATOMS ARE THERE IN 69.497 GRAMS OF Ti ?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 83.72
   H 16.28
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN H_4N_2.

Problem Set 9

1. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_5O_2N$.

2. WHAT IS THE MASS IN GRAMS OF 6.00781E+24 ATOMS OF S ?

3. THE EMPIRICAL FORMULA OF A COMPOUND IS C_3H_7.
   ITS MOLECULAR WEIGHT IS 86.00. WHAT IS ITS MOLECULAR FORMULA?

4. WHAT IS THE MASS (IN GRAMS) OF 9.260 MOLES OF $Pb(NO_3)_2$?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 5.88
   O 94.12
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. HOW MANY MOLES OF C ATOMS ARE THERE IN 24.798 GRAMS OF $NaHCO_3$?

Problem Set 10

1. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_6H_6.

2. HOW MANY GRAMS OF O ARE IN 2.900 MOLES OF CO_2?

3. IF ONE ATOM OF ELEMENT X WEIGHS 4.665E-23 G, WHAT IS THE
   ATOMIC WEIGHT OF X ?

4. THE EMPIRICAL FORMULA OF A COMPOUND IS CH_3.
   ITS MOLECULAR WEIGHT IS 30.00. WHAT IS ITS MOLECULAR FORMULA?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 10.81
   H 2.70
   O 28.83
   S 57.66
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. WHAT IS THE MASS (IN GRAMS) OF 1.510 MOLES OF SO_2?

Problem Set 11

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 67.92
   H 5.66
   N 26.42
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. HOW MANY MOLECULES OF HBr ADD UP TO A MASS OF 6.750 GRAMS?

3. IF ONE ATOM OF ELEMENT X WEIGHS 5.889E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

4. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_{16}H_8O_2S_2$.

5. HOW MANY GRAMS OF F ARE IN 4.315 MOLES OF SeF_4?

6. THE EMPIRICAL FORMULA OF A COMPOUND IS $C_3H_2NO_2$.
   ITS MOLECULAR WEIGHT IS 168.00. WHAT IS ITS MOLECULAR FORMULA?

Problem Set 12

1. HOW MANY MOLECULES OF NO ADD UP TO A MASS OF 47.149 GRAMS?

2. HOW MANY GRAMS IS 2.620 GRAM ATOMS OF Ge?

3. THE EMPIRICAL FORMULA OF A COMPOUND IS C_3H_4N.
   ITS MOLECULAR WEIGHT IS 108.00. WHAT IS ITS MOLECULAR FORMULA?

4. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 12.50
   N 87.50
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

5. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_6O_4S_4$.

6. HOW MANY GRAMS OF Al ARE IN 4.050 MOLES OF $Al(OH)_3$?

Problem Set 13

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 82.76
   H 17.24
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. ONE MOLE OF NiS IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF $ScCl_3$ MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF NiS ?

3. WHAT IS THE MASS IN GRAMS OF 4.94832E+24 ATOMS OF Cu ?

4. THE EMPIRICAL FORMULA OF A COMPOUND IS C_2H_4S.
   ITS MOLECULAR WEIGHT IS 120.00. WHAT IS ITS MOLECULAR FORMULA?

5. HOW MANY MOLES OF Ni ATOMS ARE THERE IN 80.999 GRAMS OF NiS?

6. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_5O_2N$.

Problem Set 14

1. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_2H_6O.

2. HOW MANY GRAMS IS 7.810 GRAM ATOMS OF Zn?

3. HOW MANY MOLECULES OF F_2 ADD UP TO A MASS OF 44.999 GRAMS?

4. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 4.12
   O 62.92
   S 35.96
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

5. THE EMPIRICAL FORMULA OF A COMPOUND IS C_8H_4OS.
   ITS MOLECULAR WEIGHT IS 296.00. WHAT IS ITS MOLECULAR FORMULA?

6. HOW MANY ATOMS OF Sn ARE THERE IN 6.400 GRAMS OF $SnCl_2$?

Problem Set 15

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 67.92
   H 5.66
   N 26.42
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. HOW MANY GRAMS OF C ARE IN 3.135 MOLES OF $NaHCO_3$?

3. ONE MOLE OF CaO IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF C_6H_6 MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF CaO ?

4. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN SO_2 ?

5. WHAT IS THE MASS IN GRAMS OF 5.44803E+24 ATOMS OF Cl ?

6. THE EMPIRICAL FORMULA OF A COMPOUND IS $CH_3O_2S_2$.
   ITS MOLECULAR WEIGHT IS 222.00. WHAT IS ITS MOLECULAR FORMULA?

Problem Set 16

1. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_4H_{10}.

2. IF ONE ATOM OF ELEMENT X WEIGHS 7.957E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

3. THE EMPIRICAL FORMULA OF A COMPOUND IS HNO_3.
   ITS MOLECULAR WEIGHT IS 63.00. WHAT IS ITS MOLECULAR FORMULA?

4. HOW MANY MOLECULES OF NH_3 ADD UP TO A MASS OF 29.150 GRAMS?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 60.87
   H 4.35
   O 34.78
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. HOW MANY GRAMS OF O ARE IN 3.335E+24 MOLECULES OF CO_2?

Problem Set 17

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 2.13
   N 29.79
   S 68.09
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. THE EMPIRICAL FORMULA OF A COMPOUND IS $C_3H_2NO_2$.
   ITS MOLECULAR WEIGHT IS 168.00. WHAT IS ITS MOLECULAR FORMULA?

3. HOW MANY GRAMS OF Br ARE IN 5.881E+24 MOLECULES OF Br_2?

4. ONE MOLE OF $Pb(NO_3)_2$ IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE.
   HOW MANY MOLES OF KI MUST BE PLACED ON THE OTHER PAN
   TO EXACTLY BALANCE THE MOLE OF $Pb(NO_3)_2$?

5. HOW MANY ATOMS ARE THERE IN 75.100 GRAMS OF O ?

6. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_8N_2$.

Problem Set 18

1. HOW MANY MOLECULES OF N_2 ADD UP TO A MASS OF 8.149 GRAMS?

2. THE EMPIRICAL FORMULA OF A COMPOUND IS C_2H_4NO.
   ITS MOLECULAR WEIGHT IS 116.00. WHAT IS ITS MOLECULAR FORMULA?

3. HOW MANY GRAMS OF F ARE IN 5.718E+23 MOLECULES OF HF?

4. HOW MANY ATOMS ARE THERE IN 98.498 GRAMS OF Cr ?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 66.67
   H 7.41
   N 25.93
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN AsH_3 ?

Problem Set 19

1. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_6H_8N_2$.

2. ONE MOLE OF PCl_3 IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF AsH_3 MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF PCl_3 ?

3. THE EMPIRICAL FORMULA OF A COMPOUND IS C_8H_4OS. ITS MOLECULAR WEIGHT IS 296.00. WHAT IS ITS MOLECULAR FORMULA?

4. HOW MANY GRAM ATOMS OF I ARE THERE IN 52.697 GRAMS OF I ?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   O 69.57
   N 30.43
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

6. HOW MANY GRAMS OF O ARE IN 2.787E+24 MOLECULES OF N_2O_4?

Problem Set 20

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 12.50
   N 87.50
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. THE EMPIRICAL FORMULA OF A COMPOUND IS $C_9H_8O_4$. ITS MOLECULAR WEIGHT IS 180.00. WHAT IS ITS MOLECULAR FORMULA?

3. HOW MANY MOLES OF C ATOMS ARE THERE IN 15.600 GRAMS OF CaO?

4. ONE MOLE OF HBr IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF C_2H_6 MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF HBr ?

5. HOW MANY GRAM ATOMS OF Na ARE THERE IN 49.297 GRAMS OF Na ?

6. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_4N_2S_2$.

The CM Project

The Computer-enriched Module (CM) project is a collaborative effort by 19 faculty members in the disciplines of chemistry, mathematics and physics, to produce self-instructional computer-based materials at the introductory college level in those disciplines. Each module is designed to be usable in an academic environment with minimal computational facilities, and by students and faculty who are not programming experts. It may be used as an adjunct to standard textual materials, or in many cases, as a replacement for them. The primary aim of each module is to use the computer in such a way that students may take a more active role in the development and discovery of concepts and phenomena.

CM Project Staff

Chemistry	Mathematics	Physics
C. J. Jameson Chem. Group Leader U. of Ill. - CC Chicago, IL	J. H. Mayne Math. Group Leader Loyola University Chicago, IL	H. Weinstock Phys. Group Leader IIT Chicago, IL
M. Bader Moravian College Bethlehem, PA	R. A. Alo Carnegie-Mellon U. Pittsburgh, PA	D. Davidson Pima Comm. Coll. Tucson, AR
A. K. Jameson Loyola University Chicago, IL	N. C. Harbertson Cal. St. Univ. Fresno, CA	P. Goldstein Jersey City St. C. Jersey City, NJ
J. Manock Western Carolina U. Cullowhee, NC	L. C. Leinbach Gettysburg College Gettysburg, PA	W. Lang MacMurray College Jacksonville, IL
R. T. O'Neill Xavier University Cincinnati, OH	J. C. Mathews Iowa State Univ. Ames, IA	L. E. Turner, Jr. Pacific Union Coll. Angwin, CA
F. A. Settle, Jr. Va. Military Inst. Lexington, VA	L. E. Mauland U. of North Dakota Grand Forks, ND	S. L. Wiley Cal. State Univ. Dominguez Hills, CA
R. Williams (formerly) U. of Neb. Lincoln, NB		

Address all correspondence to

Professor H. Weinstock
Director, CM Project
Physics Department
Illinois Institute of Technology
Chicago, Illinois 60616

TEACHER'S GUIDE TO
A MODULE ON STOICHIOMETRY
UNIT 1. THE MOLE CONCEPT

ROBERT C. WILLIAMS
UNIVERSITY OF NEBRASKA

a computer-enriched module
for introductory chemistry
featuring the program

MOLE

Supported by grants from the
National Science Foundation
Exxon Foundation

Copyright by CM Publications 1976
Illinois Institute of Technology

TEACHER'S GUIDE TO UNIT ON THE MOLE CONCEPT OF THE STOICHIOMETRY MODULE

EDUCATIONAL OBJECTIVES

The purpose of this module is to introduce the mole concept, together with the necessary techniques and definitions for interconversion of weights, moles, numbers of atoms or molecules, and percent compositions. Additionally, methods for computation of empirical and molecular formulas are discussed. The pedagogical approach is straightforward. Nineteen examples of increasing complexity are scattered through the module. Twenty problem sets are also included.

IMPLEMENTATION

The unit fits in early in the first semester of the Freshman sequence. The total time for terminal use should be relatively small (only a few minutes per student) since the BASIC program (MOLE) included in this guide generates unique exams of 5 questions for each student. It is intended that he or she take the exam away, solve the problems, and then return to the terminal for checking of the answers. The program makes extensive use of the RND function of BASIC to insure individual exams are different.

For completeness, an optional section on volume of a gas at standard temperature and pressure has been included, together with several problems on these relationships.

References

1. C. L. Wilkins, C. E. Klopfenstein, T. L. Isenhour, and P. C. Jurs, "Introduction to Computer Programming for Chemists -- BASIC Version" Allyn and Bacon, Inc., Boston (1974).

Molar Masses of Compounds	pp 107-121
Empirical Formulas	pp 159-164
Molecular Mass and Percent Composition	pp 231-236

ANSWERS TO PROBLEM SETS

TEST 1

1. H 7.74886E+00
2. 9.28E+23
3. CH_3
4. C_2H_6O
5. 9.39E-02
6. 4.11E-01

TEST 2

1. $C_2H_8N_2$
2. 83.72 % C
   16.28 % H
2.
3. 8.45E+01
4. 4.95E+23
5. 1.11E+02
6. CH_3O_2

TEST 3

1. 1.08E+00
2. 7.83E+23
3. H 7.74886E+00
4. CH_3
5. C_6H_6
6. 4.79E+01

TEST 4

1. 1.25E+02
2. 2.01E+24
3. $C_3H_2NO_2$
4. 83.72 % C
   16.28 % H
4.
5. $C_2H_6O_4N_4$
6. 9.20E+01

TEST 5

1. $CH_3N_2O_2$
2. 1.38E+00
3. 3.55E+02
4. C_6H_{14}
5. 1.98E+00
6. O 2.85207E+01

TEST 6

1. C_2H_6O
2. $C_7H_6O_3$
3. 2.55E+22
4. 5.07E+02
5. 7.54E-01
6. Cu 3.98115E+01

TEST 7

1. $CH_3O_2S_2$
2. 3.58E+01
3. 9.46E-01
4. 3.88E+23
5.
   32.00 % C
   6.67 % H
   42.67 % O
   18.67 % N
5.
6. $C_3H_7O_2N$

TEST 8

1. 1.19E+00
2. O_4N_2
3. 1.30E+02
4. 8.73E+23
5. C_3H_7
6.
   12.50 % H
   87.50 % N
6.

TEST 9

1.
   32.00 % C
   6.67 % H
   42.67 % O
   18.67 % N
1.
2. 3.20E+02
3. C_6H_{14}
4. 3.07E+03
5. HO
6. 2.95E-01

TEST 10

1.
   92.31 % C
   7.69 % H
1.
2. 9.28E+01
3. 2.81E+01
4. C_2H_6
5. $CH_3O_2S_2$
6. 9.66E+01

TEST 11

1. C_3H_3N
2. 5.02E+22
3. 3.55E+01
4.
   64.86 % C
   2.70 % H
   10.81 % O
   21.62 % S
4.
5. 3.28E+02
6. $C_6H_4O_4N_2$

TEST 12

1. 9.46E+23
2. 1.90E+02
3. $C_6H_8N_2$
4. NH_2
5.
   10.81 % C
   2.70 % H
   28.83 % O
   57.66 % S
5.
6. 1.09E+02

TEST 13

1. C_2H_5
2. 6.00E-01
3. 5.22E+02
4. $C_4H_8S_2$
5. 8.92E-01
6.
   32.00 % C
   6.67 % H
   42.67 % O
   18.67 % N

TEST 14

1.
   52.17 % C
   13.04 % H
   34.78 % O
1.
2. 5.11E+02
3. 7.13E+23
4. $H_2S_2O_7$
5. $C_{16}H_8O_2S_2$
6. 2.03E+22

TEST 15

1. C_3H_3N
2. 3.76E+01
3. 7.19E-01
4. S 5.00999E+01
5. 3.21E+02
6. $C_2H_6O_4S_4$

TEST 16

1.
   82.76 % C
   17.24 % H
1.
2. 4.79E+01
3. HO_3N
4. 1.03E+24
5. $C_7H_6O_3$
6. 1.77E+02

TEST 17

1. HSN
2. $C_6H_4O_4N_2$
3. 1.56E+03
4. 2.00E+00
5. 2.83E+24
6.
   40.00 % C
   13.33 % H
   46.67 % N

TEST 18

1. 1.75E+23
2. $C_4H_8O_2N_2$
3. 1.80E+01
4. 1.14E+24
5. C_3H_4N
6. As 9.61204E+01

TEST 19

1.
66.67 % C
7.41 % H
25.93 % N
1.

2. 1.76E+00

3. $C_{16}H_8O_2S_2$

4. 4.15E-01

5. NO_2

6. 2.96E+02

TEST 20

1. NH_2

2. $C_8H_8O_4$

3. 2.78E-01

4. 2.69E+00

5. 2.14E+00

6.
20.00 % C
3.33 % H
23.33 % N
53.33 % S

SOFTWARE

Since random number generating functions may vary from one computer to another, the random number generator in MOLE is included in the program listing. The same series of random real numbers are generated for the same initial seed. The seed used in printing a quiz requested by a student is printed out as the exam number. This same number, when typed in by the student upon return to the terminal for grading, regenerates the same series of random numbers. Thus, the identical set of questions in the quiz are regenerated, making the grading of the student's answers possible.

Sample runs of MOLE showing first, a quiz being printed and then, the student's answers being graded

```
PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?12391
O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?1

--------------------------------------------------------------------------

EXAM NUMBER 11618

STEVE

THERE ARE 7 QUESTIONS ON THIS EXAM.
THEY ARE ALL ON THE MOLE CONCEPT.
PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK
WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED.


QUESTION.  1
HOW MANY MOLES ARE THERE IN 145  GRAMS OF
COPPER  (AT. WT. = 63.54)?

QUESTION.  2
YOU HAVE 21   MOLES OF SODIUM CHLORIDE  (NACL).
HOW MANY GRAMS OF SODIUM DO YOU HAVE?

QUESTION.  3
YOU HAVE 5.40002E+24   ATOMS OF SILICON  (SI).
HOW MANY MOLES OF SILICON DO YOU HAVE?

QUESTION.  4
HOW MANY ATOMS ARE THERE IN 6.8
GRAMS OF WATER?

QUESTION.  5
YOU HAVE 4.20001E+24   MOLECULES OF HCL.
HOW MANY GRAMS DO YOU HAVE?

QUESTION.  6
HOW MANY GRAMS OF CARBON ARE CONTAINED IN 66
GRAMS OF A COMPOUND THAT IS 70.7        PER CENT CARBON?

QUESTION.  7
HOW MANY MOLES ARE CONTAINED IN 16
GRAMS OF C 35   H 70   O 1 ?


--------------------------------------------------------------------------
GOOD LUCK STEVE, AND HURRY BACK.
```

```
PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?0
 PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?57
O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?2
PLEASE ENTER YOUR EXAM NUMBER.
?11618
PLEASE ENTER YOUR 7 ANSWERS IN THE EXACT ORDER OF THE QUESTIONS.
PRESS (RETURN) AFTER EACH ANSWER.
?2.28
?462
?8.97
?6.82E23
?251.2
?46.7
?3.2E-2

---------------------------------------------------------------------------

EXAM NUMBER 11618

STEVE


CORRECT          YOUR
ANSWER           ANSWER          RESULT

 2.28202          2.27999        CORRECT
 482.81           462            CORRECT
 8.96564          8.96999        CORRECT
 6.82040E+23      6.82000E+23    CORRECT
 254.245          251.2          CORRECT
 46.662           46.7           CORRECT
 3.15616E-02      3.19999E-02    CORRECT

YOUR GRADE ON THIS QUIZ IS 100  %

---------------------------------------------------------------------------
MARVELOUS FRIEND, YOU HAVE BEATEN THIS BROKEN MACHINE.
WOULD YOU LIKE TO TAKE ANOTHER QUIZ?
ENTER 1 FOR YES, 2 FOR NO.
?2
GOOD LUCK STEVE, AND HURRY BACK.

READY
```

```
PLEASE TYPE IN YOUR NAME
BUMB

BUMB PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?793
O.K. BUMB, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?9
PLEASE ENTER 1 OR 2!
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?1

--------------------------------------------------------------------------

EXAM NUMBER 17492

BUMB

THERE ARE 7 QUESTIONS ON THIS EXAM.
THEY ARE ALL ON THE MOLE CONCEPT.
PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK
WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED.


QUESTION.  1
HOW MANY MOLES ARE THERE IN 141  GRAMS OF
CARBON MONOXIDE  (MOLECULAR WT. = 28.011)?

QUESTION.  2
YOU HAVE 65   MOLES OF METHANE  (CH4).
HOW MANY GRAMS OF C DO YOU HAVE?

QUESTION.  3
YOU HAVE 4.30001E+24   ATOMS OF SILICON  (SI).
HOW MANY MOLES OF SILICON DO YOU HAVE?

QUESTION.  4
HOW MANY ATOMS ARE THERE IN 6.4
MOLES OF METHANE  (CH4)?

QUESTION.  5
YOU HAVE 5.80002E+24   MOLECULES OF HCL.
HOW MANY GRAMS DO YOU HAVE?

QUESTION.  6
HOW MANY GRAMS OF CARBON ARE CONTAINED IN 78
GRAMS OF A COMPOUND THAT IS 22.1        PER CENT CARBON?

QUESTION.  7
THE FORMULA OF AN ALKYL HALIDE IS C 17   H 35   BR 1.
WHAT IS THE WEIGHT % OF BROMINE FOR THIS COMPOUND?


--------------------------------------------------------------------------
GOOD LUCK BUMB, AND HURRY BACK.
```

```
PLEASE TYPE IN YOUR NAME
DUMB

DUMB PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?9
O.K. DUMB, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?2
PLEASE ENTER YOUR EXAM NUMBER.
?17492
PLEASE ENTER YOUR 7 ANSWERS IN THE EXACT ORDER OF THE QUESTIONS.
PRESS (RETURN) AFTER EACH ANSWER.
?5.1
?703.9
?7.2
?2.4E19
?297.4
?12.7
?55.4

--------------------------------------------------------------------------

EXAM NUMBER 17492

DUMB


CORRECT          YOUR
ANSWER           ANSWER          RESULT

 5.03374          5.09999        CORRECT
 780.715          703.9          WRONG
 7.13931          7.19999        CORRECT
 1.92736E+25      2.40000E+19    WRONG
 351.101          297.399        WRONG
 17.238           12.6999        WRONG
 25.0191          55.4           WRONG

YOUR GRADE ON THIS QUIZ IS 29   %

--------------------------------------------------------------------------
WOULD YOU LIKE TO TAKE ANOTHER QUIZ?
ENTER 1 FOR YES, 2 FOR NO.
?2
GOOD LUCK DUMB, AND HURRY BACK.

READY
```

BASIC PRØGRAM MØLE ØN THU, AUG 21, 1975, 12:20 PM

```
NAME  MØLE
  10 REM ************************************************************
  20 REM ***
  30 REM *** THIS IS A TWØ PASS PRØGRAM IN WHICH PRØBLEMS WILL BE
  40 REM *** SELECTED AT RANDØM.  AFTER ANSWERING THE QUESTIØNS
  50 REM *** THE STUDENT WILL RETURN AND SUBMIT HIS ANSWERS.  THE
  60 REM *** CØMPUTER WILL THEN GRADE HIS RESULTS.
  70 REM ***
  80 REM ************************************************************
  90 DIM B[7],C[7],A$[20]
 100 LET K=G=0
 110 PRINT
 120 PRINT
 130 PRINT "PLEASE TYPE IN YØUR NAME"
 140 INPUT A$
 150 PRINT
 160 PRINT A$;
 170 PRINT " PLEASE INPUT A NUMBER FRØM 1 THRU 15,000."
 180 INPUT S
 190 LET S=INT(S)
 200 IF S<1 THEN 170
 210 IF S>15000 THEN 170
 220 PRINT "Ø.K. ";
 230 PRINT A$;
 240 PRINT ", DØ YØU WISH TØ TAKE A TEST ØR HAVE YØUR TEST GRADED?"
 250 PRINT "IF YØU WISH TØ TAKE A TEST, ENTER A 1, AND IF YØU WISH TØ"
 260 PRINT "HAVE AN EXAM GRADED, ENTER A 2."
 270 LET P=1
 280 INPUT Y
 290 IF Y=1 THEN 470
 300 LET K=K+1
 310 IF Y=2 THEN 350
 320 IF K>3 THEN 3140
 330 PRINT "PLEASE ENTER 1 ØR 21"
 340 GØTØ 250
 350 PRINT "PLEASE ENTER YØUR EXAM NUMBER."
 360 INPUT X
 370 PRINT "PLEASE ENTER YØUR 7 ANSWERS ";
 380 PRINT "IN THE EXACT ØRDER ØF THE QUESTIØNS."
 390 PRINT "PRESS (RETURN) AFTER EACH ANSWER."
 400 FØR U=1 TØ 7
 410   INPUT C[U]
 420 NEXT U
 430 LET S=X
 440 LET R=X
 450 LET P=2
 460 GØTØ 510
 470 GØSUB 2860
 480 LET S=R1
 490 LET R=INT(10000.5+22000*R2)
 500 LET S=R
 510 PRINT
 520 PRINT
 530 PRINT "-----------------------------------";
 540 PRINT "-----------------------------------"
 550 PRINT
 560 PRINT "EXAM NUMBER";R
```

```
570 PRINT
580 PRINT A$;
590 PRINT
600 PRINT
610 IF P<>1 THEN 660
620 PRINT "THERE ARE 7 QUESTIØNS ØN THIS EXAM."
630 PRINT "THEY ARE ALL ØN THE MØLE CØNCEPT."
640 PRINT "PLEASE ANSWER THE QUESTIØNS AT HØME, AND CØME BACK"
650 PRINT "WHEN YØU ARE READY TØ HAVE YØUR EXAM GRADED."
660 PRINT
670 PRINT
680 LET I=0
690 GØSUB 2860
700 LET R3=INT(31.1999+126.9*R2)
710 GØSUB 2860
720 LET R=INT(1.5+4*R2)
730 GØSUB 3080
740 IF P<>1 THEN 760
750 PRINT "HØW MANY MØLES ARE THERE IN";R3;"GRAMS ØF"
760 GØTØ R ØF 770,810,850,890,930
770 IF P<>1 THEN 790
780 PRINT "CØPPER  (AT. WT. = 63.54)?"
790 LET B[I]=R3/63.54
800 GØTØ 960
810 IF P<>1 THEN 830
820 PRINT "WATER  (MØLECULAR WT. = 18.016)?"
830 LET B[I]=R3/18.016
840 GØTØ 960
850 IF P<>1 THEN 870
860 PRINT "CARBØN MØNØXIDE  (MØLECULAR WT. = 28.011)?"
870 LET B[I]=R3/28.0109
880 GØTØ 960
890 IF P<>1 THEN 910
900 PRINT "CALCIUM FLUØRIDE, CAF2  (MØLECULAR WT. = 78.08)?"
910 LET B[I]=R3/78.08
920 GØTØ 960
930 IF P<>1 THEN 950
940 PRINT "CARBØN, C  (AT. WT. = 12.011)?"
950 LET B[I]=R3/12.011
960 GØSUB 2860
970 LET R3=INT(20+60*R2)
980 GØSUB 2860
990 LET R=INT(1.5+3*R2)
1000 GØSUB 3080
1010 IF P<>1 THEN 1030
1020 PRINT "YØU HAVE";R3;"MØLES ØF ";
1030 GØTØ R ØF 1040,1090,1140,1190
1040 IF P<>1 THEN 1070
1050 PRINT "NITRØGEN  (N2)."
1060 PRINT "HØW MANY GRAMS ØF N DØ YØU HAVE?"
1070 LET B[I]=R3*28.0138
1080 GØTØ 1230
1090 IF P<>1 THEN 1120
1100 PRINT "METHANE  (CH4)."
1110 PRINT "HØW MANY GRAMS ØF C DØ YØU HAVE?"
1120 LET B[I]=R3*12.011
```

```
1130 GØTØ 1230
1140 IF P<>1 THEN 1170
1150 PRINT "METHANE  (CH4)."
1160 PRINT "HØW MANY GRAMS ØF METHANE DØ YØU HAVE?"
1170 LET B[I]=R3*16.043
1180 GØTØ 1230
1190 IF P<>1 THEN 1220
1200 PRINT "SØDIUM CHLØRIDE  (NACL)."
1210 PRINT "HØW MANY GRAMS ØF SØDIUM DØ YØU HAVE?"
1220 LET B[I]=R3*22.9909
1230 GØSUB 2860
1240 LET R3=(INT(20+60*R2)/10)*1E24
1250 GØSUB 2860
1260 LET R=INT(1.5+3*R2)
1270 GØSUB 3080
1280 IF P<>1 THEN 1300
1290 PRINT "YØU HAVE";R3;
1300 GØTØ R ØF 1310,1360,1410,1460
1310 IF P<>1 THEN 1340
1320 PRINT "MØLECULES ØF ETHANØL  (C2H5ØH)."
1330 PRINT "HØW MANY MØLES ØF ETHANØL DØ YØU HAVE?"
1340 LET B[I]=R3/6.02301E23
1350 GØTØ 1500
1360 IF P<>1 THEN 1390
1370 PRINT "MØLECULES ØF HYDRØGEN  (H2)."
1380 PRINT "HØW MANY MØLES ØF H DØ YØU HAVE?"
1390 LET B[I]=2*R3/6.02301E23
1400 GØTØ 1500
1410 IF P<>1 THEN 1440
1420 PRINT "ATØMS ØF SILICØN  (SI)."
1430 PRINT "HØW MANY MØLES ØF SILICØN DØ YØU HAVE?"
1440 LET B[I]=R3/6.02301E23
1450 GØTØ 1500
1460 IF P<>1 THEN 1490
1470 PRINT "ATØMS ØF NITRØGEN  (N)."
1480 PRINT "HØW MANY MØLES ØF N2 GAS DØ YØU HAVE?"
1490 LET B[I]=(R3/6.02301E23)*.5
1500 GØSUB 2860
1510 LET R3=INT(20+60*R2)/10
1520 GØSUB 2860
1530 LET R=INT(1.5+3*R2)
1540 GØSUB 3080
1550 IF P<>1 THEN 1570
1560 PRINT "HØW MANY ATØMS";
1570 GØTØ R ØF 1580,1630,1680,1730
1580 IF P<>1 THEN 1610
1590 PRINT " ØF CARBØN ARE THERE IN "
1600 PRINT R3;"MØLES ØF TØULENE  (C7H8)?"
1610 LET B[I]=7*R3*6.02301E23
1620 GØTØ 1770
1630 IF P<>1 THEN 1660
1640 PRINT " ØF FLØURINE ARE THERE IN "
1650 PRINT R3;"GRAMS ØF SILICØN TETRAFLUØRIDE  (SIF4)?"
1660 LET B[I]=(R3/104.086)*4*6.02301E23
1670 GØTØ 1770
1680 IF P<>1 THEN 1710
```

```
1690 PRINT " ARE THERE IN";R3
1700 PRINT "MØLES ØF METHANE  (CH4)?"
1710 LET B[I]=R3*5*6.02301E23
1720 GØTØ 1770
1730 IF P<>1 THEN 1760
1740 PRINT " ARE THERE IN";R3
1750 PRINT "GRAMS ØF WATER?"
1760 LET B[I]=3*6.02301E23*(R3/18.015)
1770 GØSUB 2860
1780 LET R3=(INT(27+60*R2)/10)*1E24
1790 GØSUB 2860
1800 LET R=INT(1.5+3*R2)
1810 GØSUB 3080
1820 IF P<>1 THEN 1840
1830 PRINT "YØU HAVE";R3;
1840 GØTØ R ØF 1850,1900,1950,2000
1850 IF P<>1 THEN 1880
1860 PRINT "ATØMS ØF SILICØN."
1870 PRINT "HØW MANY GRAMS DØ YØU HAVE?"
1880 LET B[I]=28.086*(R3/6.02301E23)
1890 GØTØ 2040
1900 IF P<>1 THEN 1930
1910 PRINT "MØLECULES ØF HCL."
1920 PRINT "HØW MANY GRAMS DØ YØU HAVE?"
1930 LET B[I]=36.46*(R3/6.02301E23)
1940 GØTØ 2040
1950 IF P<>1 THEN 1980
1960 PRINT "ATØMS ØF CARBØN."
1970 PRINT "HØW MANY GRAMS ØF CARBØN DIØXIDE (CØ2) CAN YØU MAKE?"
1980 LET B[I]=(R3/6.02301E23)*44.009
1990 GØTØ 2040
2000 IF P<>1 THEN 2030
2010 PRINT "MØLECULES ØF BRØMINE."
2020 PRINT "HØW MANY GRAMS DØ YØU HAVE?"
2030 LET B[I]=(R3/6.02301E23)*(2*79.916)
2040 GØSUB 2860
2050 LET R3=INT(10+980*R2)/10
2060 GØSUB 2860
2070 LET R=INT(1.5+R2)
2080 GØSUB 3080
2090 GØTØ R ØF 2100,2160
2100 LET R4=INT(13+200*R2)
2110 IF P<>1 THEN 2140
2120 PRINT "HØW MANY GRAMS ØF CARBØN ARE CØNTAINED IN";R4
2130 PRINT "GRAMS ØF A CØMPØUND THAT IS";R3;"PER CENT CARBØN?"
2140 LET B[I]=R4*(R3/100)
2150 GØTØ 2240
2160 GØSUB 2860
2170 LET R4=INT(150+990*R2)/100
2180 LET R5=R3+R4
2190 IF P<>1 THEN 2230
2200 PRINT "A MIXTURE ØF";R5;"GRAMS ØF A + B CØNTAINS";R3
2210 PRINT "GRAMS ØF A."
2220 PRINT "WHAT IS THE WEIGHT PERCENT ØF A IN THE MIXTURE?"
2230 LET B[I]=(R3/R5)*100
2240 GØSUB 3080
```

```
2250 GØSUB 2860
2260 LET R3=INT(15+99*R2)
2270 LET R4=INT(2*R3+1)
2280 GØSUB 2860
2290 LET R=INT(1.5+2*R2)
2300 GØTØ R ØF 2310,2360,2420
2310 IF P<>1 THEN 2340
2320 PRINT "THE FØRMULA ØF AN ALKYL HALIDE IS C";R3;"H";R4;"BR 1."
2330 PRINT "WHAT IS THE WEIGHT % ØF BRØMINE FØR THIS CØMPØUND?"
2340 LET B[I]=((79.904)/((R3*12.011)+(R4*1.008)+79.904))*100
2350 GØTØ 2490
2360 LET R4=INT(R4-1)
2370 IF P<>1 THEN 2400
2380 PRINT "THE FØRMULA ØF A KETØNE IS C";R3;"H";R4;"Ø 1."
2390 PRINT "WHAT IS THE WEIGHT % ØF ØXYGEN FØR THIS CØMPØUND?"
2400 LET B[I]=(15.999/((R3*12.011)+(R2*1.008)+15.999))*100
2410 GØTØ 2490
2420 LET R4=INT(R4-1)
2430 GØSUB 2860
2440 LET R5=INT(15+99*R2)
2450 IF P<>1 THEN 2480
2460 PRINT "HØW MANY MØLES ARE CØNTAINED IN";R5
2470 PRINT "GRAMS ØF C";R3;"H";R4;"Ø 1 ?"
2480 LET B[I]=R5/((R3*12.011)+(R4*1.008)+15.999)
2490 IF P=1 THEN 2610
2500 PRINT "CØRRECT","YØUR"
2510 PRINT "ANSWER","ANSWER","RESULT"
2520 PRINT
2530 FØR I=1 TØ 7
2540   IF B[I]>1.05*C[I] THEN 2590
2550   IF B[I]<.95*C[I] THEN 2590
2560   PRINT B[I],C[I],"CØRRECT"
2570   LET G=G+100/7
2580   GØTØ 2600
2590   PRINT B[I],C[I],"WRØNG"
2600 NEXT I
2610 PRINT
2620 IF P=1 THEN 2640
2630 PRINT "YØUR GRADE ØN THIS QUIZ IS";INT(G+.5);"%"
2640 PRINT
2650 PRINT "-----------------------------------";
2660 PRINT "-----------------------------------"
2670 IF INT(G+.5)<>100 THEN 2690
2680 PRINT "MARVELØUS FRIEND, YØU HAVE BEATEN THIS BRØKEN MACHINE."
2690 IF P<>1 THEN 2740
2700 PRINT "GØØD LUCK ";
2710 PRINT A$;
2720 PRINT ", AND HURRY BACK."
2730 PRINT
2740 IF P=1 THEN 3180
2750 IF P=9999 THEN 3180
2760 PRINT "WØULD YØU LIKE TØ TAKE ANØTHER QUIZ?"
2770 PRINT "ENTER 1 FØR YES, 2 FØR NØ."
2780 INPUT Z
2790 LET P=1
2800 LET G=0
```

```
2810 IF Z=1 THEN 470
2820 IF Z=2 THEN 2840
2830 GØTØ 2770
2840 LET P=9999
2850 GØTØ 2700
2860 REM ************************************************************************
2870 REM ***
2880 REM *** THIS IS THE RANDØM NUMBER GENERATØR.
2890 REM *** GIVEN A SEED, S, IT PRØDUCES A RANDØM INTEGER (R1)
2900 REM *** FRØM 1 THRU 16,384 AND A RANDØM REAL NUMBER (R2)
2910 REM *** FRØM 0 THRU 1.
2920 REM ***
2930 LET A=131
2940 LET M=16384
2950 REM *** MAKE SURE THE SEED IS ØDD.
2960 IF (INT(S/2))*2<>S THEN 2980
2970 LET S=INT(S+1)
2980 LET T=A*S
2990 LET Q=INT(T/M)
3000 LET R1=T-Q*M
3010 LET R2=R1/(M-1)
3020 REM *** SET THE NEW SEED TØ THE VALUE ØF THE RANDØM INTEGER
3030 REM *** JUST GENERATED.
3040 LET S=R1
3050 REM *** THIS INSURES THAT THE SERIES ØF RANDØM REAL NUMBERS
3060 REM *** GENERATED FØR THE SAME INITIAL SEED WILL BE IDENTICAL.
3070 RETURN
3080 REM ************************************************************************
3090 LET I=I+1
3100 IF P=2 THEN 3130
3110 PRINT
3120 PRINT "QUESTIØN. ";I
3130 RETURN
3140 PRINT "SØRRY ";
3150 PRINT A$;
3160 PRINT ", PLEASE GET SØME HELP.  SØ LØNG FØR NØW."
3170 STØP
3180 END
```

Unit Test on the Mole Concept

TEST 1

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 42.86
   H 2.38
   O 38.10
   N 16.67
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. HOW MANY MOLES OF SC_2 MOLECULES ARE THERE IN 25.849 GRAMS OF SO_2 ?

3. HOW MANY GRAM ATOMS OF O ARE THERE IN 70.498 GRAMS OF O ?

4. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN $Ti(OH)_4$?

5. HOW MANY MOLES OF Li ATOMS ARE THERE IN 17.797 GRAMS OF LiOH?

TEST 1

1. $C_3H_2NO_2$
2. 4.04E-01
3. 4.41E+00
4. Ti 4.13183E+01
5. 7.43E-01

Unit Test on the Mole Concept

TEST 2

1. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN C_2H_6 ?

2. HOW MANY MOLECULES OF NO ADD UP TO A MASS OF 38.949 GRAMS?

3. HOW MANY GRAM ATOMS OF O ARE THERE IN 75.298 GRAMS OF O ?

4. HOW MANY GRAMS OF O ARE IN 3.209E+24 MOLECULES OF N_2O_4?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 1.59
   O 76.19
   N 22.22
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

TEST 2

1. H 2.01273E+01

2. 7.82E+23

3. 4.71E+00

4. 3.41E+02

5. HNO_3

Unit Test on the Mole Concept

TEST 3

1. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN CaF_2 ?

2. HOW MANY ATOMS ARE THERE IN 23.599 GRAMS OF O ?

3. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 47.06
   H 5.88
   O 47.06
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

4. WHAT IS THE MOLECULAR WEIGHT OF NO_2 ?

5. HOW MANY GRAMS OF Sn ARE IN 3.450 MOLES OF $SnCl_2$?

TEST 3

1. Ca 5.13340E+01

2. 8.88E+23

3. $C_4H_6O_3$

4. 4.60E+01

5. 4.09E+02

Unit Test on the Mole Concept

TEST 4

1. HOW MANY ATOMS ARE THERE IN 42.397 GRAMS OF Al ?

2. HOW MANY ATOMS OF S ARE THERE IN 1.13769E+24 MOLECULES OF SO_2?

3. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN CO_2 ?

4. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 1.59
   O 76.19
   N 22.22
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

5. HOW MANY MOLECULES OF Cl_2 ADD UP TO A MASS OF 48.949 GRAMS?

TEST 4

1. 9.46E+23

2. 1.14E+24

3. O 7.27265E+01

4. HNO_3

5. 4.16E+23

Unit Test on the Mole Concept

TEST 5

1. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN NiS ?

2. HOW MANY GRAMS OF Br ARE IN 4.440 MOLES OF HBr?

3. IF ONE ATOM OF ELEMENT X WEIGHS 1.993E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

4. ONE MOLE OF AsH_3 IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF NH_4Cl MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF AsH_3 ?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 1.12
   O 62.92
   S 35.96
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

TEST 5

1. Ni 6.46770E+01

2. 3.55E+02

3. 1.20E+01

4. 1.46E+00

5. $H_2S_2O_7$

Unit Test on the Mole Concept

TEST 6

1. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN Cr_2O_3 ?

2. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 1.59
   O 76.19
   N 22.22
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

3. IF ONE ATOM OF ELEMENT X WEIGHS 9.752E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

4. HOW MANY MOLES OF PH_3 MOLECULES ARE THERE IN 14.300 GRAMS OF PH_3 ?

5. HOW MANY ATOMS OF O ARE THERE IN 6.110 GRAMS OF $Pb(NO_3)_2$?

TEST 6

1. Cr 6.84202E+01

2. HNO_3

3. 5.87E+01

4. 4.21E-01

5. 6.66E+22

Unit Test on the Mole Concept

TEST 7

1. HOW MANY ATOMS ARE THERE IN 23.498 GRAMS OF Cl ?

2. HOW MANY MOLES OF B ATOMS ARE THERE IN 18.298 GRAMS OF BF_3?

3. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_2H_6O_4N_4$.

4. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 67.92
   H 5.66
   N 26.42
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

5. ONE MOLE OF KI IS PLACED ON THE LEFT PAN OF A TWO-PAN BALANCE. HOW MANY MOLES OF $Pb(NO_3)_2$ MUST BE PLACED ON THE OTHER PAN TO EXACTLY BALANCE THE MOLE OF KI ?

TEST 7

1. 3.99E+23

2. 2.70E-01

3.
   16.00 % C
   4.00 % H
   42.67 % O
   37.33 % N
3.

4. C_3H_3N

5. 5.01E-01

Unit Test on the Mole Concept

TEST 8

1. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   H 2.13
   N 29.79
   S 68.09
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

2. WHAT IS THE PERCENT BY WEIGHT OF EACH ELEMENT IN CaO ?

3. HOW MANY MOLES OF F ATOMS ARE THERE IN 30.700 GRAMS OF BF_3?

4. IF ONE ATOM OF ELEMENT X WEIGHS 2.658E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

5. WHAT IS THE MASS (IN GRAMS) OF 9.450 MOLES OF KI?

TEST 8

1. HSN
2. O 2.85207E+01
3. 4.53E-01
4. 1.60E+01
5. 1.57E+03

Unit Test on the Mole Concept

TEST 9

1. HOW MANY GRAMS OF Li ARE IN 3.055 MOLES OF LiOH?

2. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN $C_3H_7O_2N$.

3. WHAT IS THE MOLECULAR WEIGHT OF H_2Se ?

4. IF ONE ATOM OF ELEMENT X WEIGHS 2.658E-23 G, WHAT IS THE ATOMIC WEIGHT OF X ?

5. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 40.45
   H 7.87
   O 35.96
   N 15.73
   WHAT IS ITS EMPIRICAL OR SIMPLEST FORMULA?

TEST 9

1. 2.12E+01

2.
   40.45 % C
   7.87 % H
   35.96 % O
   15.73 % N

2.

3. 8.10E+01

4. 1.60E+01

5. $C_3H_7O_2N$

Unit Test on the Mole Concept

TEST 10

1. HOW MANY GRAM ATOMS OF P ARE THERE IN 19.198 GRAMS OF P ?

2. THE PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND IS
   C 25.53
   H 6.38
   O 68.09
   WHAT IS ITS EMPIRICAL OR SIMELEST FORMULA?

3. CALCULATE THE PERCENT BY WEIGHT OF EACH ELEMENT IN O_4N_2.

4. HOW MANY MOLES OF CO_2 MOLECULES ARE THERE IN 41.799 GRAMS OF CO_2 ?

5. HOW MANY GRAMS OF C ARE IN 9.812E+23 MOLECULES OF C_2H_6?

TEST 10

1. 6.20E-01

2. CH_3O_2

3.
   69.57 % O
   30.43 % N
3.

4. 9.50E-01

5. 3.91E+01